

OFFICIAL JOURNAL OF
THE MUSHROOM GROWERS'
ASSOCIATION

MGA

BULLETIN

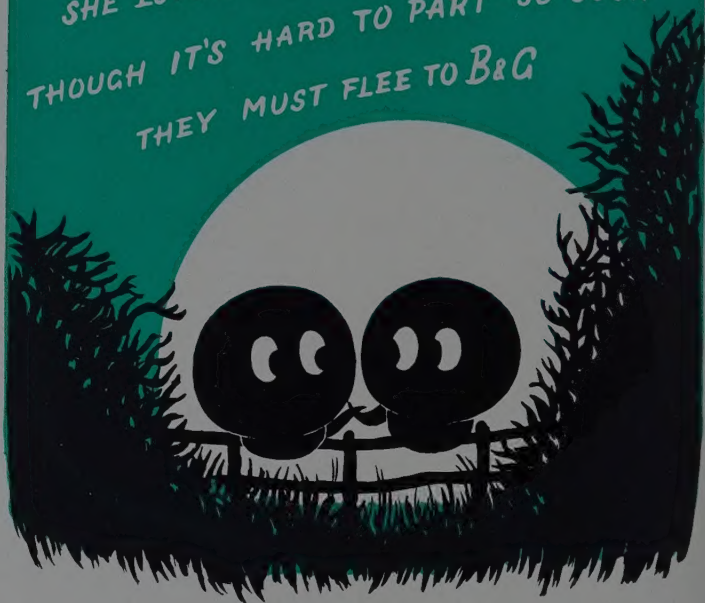
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CONTENTS

	Page
Editorial : Driven to Verse	287
Stanley Middlebrook's Diary	288
STUDIES ON THE FUNCTION OF THE CASING FOR MUSHROOM	
BEDS—I : Dr. B. B. Stoller	289
Peak Heating by Calor Gas : A. Campbell Melville	298
MGA ? MRA ?	299
The Merits of Forced Draught Equipment : C. H. Fawcett	300
Middlebrook suggests Monographs	301
Mushroom Compost for Denuded Land	301
Correspondence	302
Angmering Walk	303
New Members	303
Synthetic " Soil Conditioners " : R.L.E.	304



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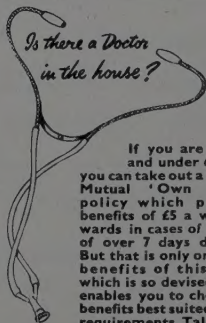
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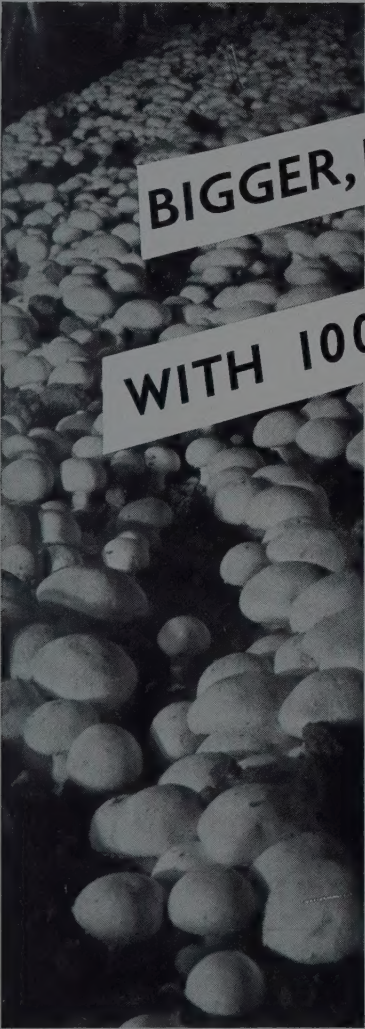
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EDITORIAL:**Driven to Verse**

The over-sensitive poet seeks escape from the grim realities of Life in his poetry. The over-sensitive lad in the frightening eternity of his late 'teens finds solace in Lines to his first-girl-friend's Eyes.

But what drives a mushroom grower to verse ?

Numerous poems have been written about mushrooms since the war. I believe it was the Bard of Brayton who started it with his Kipling parody :

*If you can trash with true and careful finger,
And water with discretion's gentle touch*

Then F.C.W. had quite a series in Darlington's "Mushroom News," including these lines based on another Bard :

*See how the compost, cunningly prepared,
Steams in the sunlight like a smoking pyre*

In Northern Ireland our old friend R.P. penned this Shakespearian comment :

Each one in its time sees many flies.

And as I write there comes with the afternoon post a Beginner's Prayer :

*Guide us through all this strange nomenclature
Which clogs increasingly the grower's art.*

This strange nomenclature ! Well, the British Standards Institution, not too soon, is endeavouring to help us here. In its latest list of recommended "common names" for pest control products are to be found zineb (with a small z) for zinc ethylenebis(dithiocarbamate) and thiram (with a small t) for TMTD or TMTDS (tetramethyl-thiuram-disulphide). I am also glad to note it spells DDT without full stops after each capital ; and the same applies to BHC.

But I feel compelled to add that, although the terminology may frighten some of us, and certain sections remain obscure to many more, technical papers concerned directly with our particular crop are almost always worth the grower's study. Dr. Stoller's three articles on Casing Soil, which start in this issue, provide an immediate example of what I mean.

As A. E. Haarer wrote in the *Fruit Grower* (24.7.52) : "**Growers need to know far more about the living things they handle.** We have taken them out of nature's balance and messed them about for our own ends, and we blame anything but ourselves if things go wrong."

Stanley Middlebrook's Diary

Aug. 11th. I am quite staggered each month as I receive our railway account for mushroom carriage. It is an expense that seems dreadfully out of proportion to other costs. Yet there is no more convenient form of transport when mushrooms are sent to widely scattered markets.

Aug. 15th. How many growers keep adequate records ? And how many who do so go to the further trouble of duplicating them ? It occurred to me the other day that in the event of fire the charts on my walls would be lost and with them the complete history of the farm's cropping. A week's work on fair copies now lies safely deposited in a fire-proof safe.

Aug. 17th. A grower tells me that he sometimes has up to 12 grades to suit his various markets. Is it degrading to de-grade ?

Aug. 22nd. Several growers seem to be cutting out soil as a casing medium. One alleges he has solved all his problems by using a mixture of two shovels of "x" with two shovels of "y" plus a couple of handfuls of "z." He has higher yields, no disease, and watering is child's play. You'd like to know what "x," "y" and "z" are ? So would I ! Maybe we shall meet this grower on October 1st. I'll stand him the first drink if you'll back me up with the rest. Let's meet him at the Connaught Rooms at 11.30.

Aug. 30th. Further to my Aug. 7th note on spawn and disease. The more I experiment with setting one spawn against another the more am I certain that spawns play a far greater part in our successes and failures than we have ever imagined. I complained of *Dactylium* appearing only in beds where a certain spawn was used. Now I find the same thing happening with Truffle, this time with another spawn. Thus we have the curious effect of *Dactylium* growing with spawn A on one side of a house and Truffle growing with spawn B on the other side. There is increasing evidence that each spawn creates a different condition within the compost : each condition being favourable perhaps to the growth of a different fungus or disease.

Sept. 1st. I shall probably be taken up on the above theory, which is obviously in its infancy anyway and may ultimately be found faulty, so I submit another "thought for to-day." I suggest that Truffle is worse with heavy manure containing a high percentage of droppings than when a more strawy racing manure is used. Take me up on that, too, if you like—on Oct. 1st.

Sept. 3rd. I never quite understand this grading craze for snipping off most of the stalk. I always find the stalk as good eating as the cap. Discarding the stalk does, however, tend to reduce the weight arriving in the markets ! Another degrading thought ?

Sept. 5th. The Editor has graciously condescended to give me an extra page this month on condition that I mention Oct. 1st, but out of spite, envy and jealousy (of my overtime pay !) he has clapped me ignominiously on to the outside back cover, where I shall be thumbed, greased, soiled, composted, trodden on, sketched on, torn, detached and destroyed. Now close the book and study the back cover while it's clean.

Studies on the Function of the Casing for Mushroom Beds

Part I : The Relation of the Abnormal Growth of the Cultivated Mushroom to Fructification and Casing Soil

By Dr. B. B. STOLLER

The significance of investigating the abnormal growth of the cultivated mushroom, *Agaricus campestris* L., besides practical considerations to the grower, is to shed light on the elusive problem of fructification. Since the seventeenth century it has been the practice to induce the development of the mushroom fruiting bodies or sporophores by covering the surface of the mycelium-impregnated compost with a layer of loam about one inch deep. The function of this layer of soil in initiating sporophore fructification has never been proved experimentally.

THE RELATION OF CO₂ TO MUSHROOM GROWTH

CO₂ and Abnormal Growth : In mushroom culture one observes sometimes that the stems of the mushroom are elongated abnormally and that, at the same time, the growth of the caps is retarded. It is generally believed that this abnormal kind of growth is due to the injurious effects of carbon dioxide released during respiration. Lambert's (2) experiments generally substantiate this assertion. By placing a bell jar over mushrooms growing on beds, and then injecting a mixture of carbon dioxide and oxygen at various concentrations, Lambert demonstrated that there was a slight tendency for the stems of mushrooms to elongate at a concentration of CO₂ of about one per cent. At concentrations of 1.8 per cent. or higher, this tendency was quite marked.

Other Factors and Abnormal Growth : It is possible, however, to demonstrate that there may occur an elongation of the stem and retardation of the cap, even in the complete absence of carbon dioxide. Such abnormal growth, especially when the mushrooms are growing thickly on the beds, has been observed by the writer in mushroom houses when no measurable amount of CO₂ could be detected. Furthermore, when peat is used to case mushroom beds, (9) deformed growth and elongated stems are commonly observed if the movement of air or ventilation is restricted, even though no CO₂ is detectable. Accordingly, the inference would be that some other factor or a volatile substance other than CO₂ is the agent responsible for these abnormalities.

Device to Show Abnormal Growth Without CO₂ : The device discovered to make such a demonstration possible was a bell jar with two openings : one opening in the top of the jar and the other in the side at the bottom, as shown in Fig. 1, No. 3 (8). When this kind of a bell jar was placed over mushrooms growing in 2-gallon earthenware pots, it was found that there was no accumulation of CO₂ in the bell jar as a result of respiration. Whereas in bell jars where there was an opening only in the top as shown in Fig. 1, Nos. 1 and 2, there was a considerable accumulation of CO₂. The openings in the jars were left open throughout the experiment, except momentarily when drawing samples for analysis. The atmosphere in the bell jars was analyzed for CO₂ with an Orsat

apparatus (accuracy 0.2%). To withdraw 100 ml. samples, a glass tube was inserted through a rubber stopper placed in the opening at the top of the bell jar and lowered to about an inch above the soil. The side opening in the bell jar with two outlets was closed with a rubber stopper during analysis. The bell jars were fastened to the pots with rubber bands cut out from inner tubes of auto tyres. Prior to fastening the jars onto the pots, the surface soil was sprinkled with 50 ml. of water in order to enhance the release of CO_2 . The CO_2 used to affect sporophore development was the gas naturally evolved from respiration, rather than that obtained from commercial cylinders and injected under the jars as in Lambert's experiments. Mushrooms were growing in the pin-size stage on pots selected for these experiments.

Measuring CO_2 in Compost : The glazed, earthenware pots were arranged also for analyzing the CO_2 in the mycelium-permeated compost as follows : When the pots were being filled with the pasteurized compost, a bent glass tube was drawn through a one-hole rubber stopper and then inserted in the hole near the bottom of the pot as shown in Fig. 1. The glass tube entered into the centre of the compost in the pot, and was bent up so that it reached to the surface of the compost. A small petri dish cover was placed over the opening of the tube before the compost was cased with soil. At the other end rubber tubing was slipped over the glass tubing and closed with a pinch cock. Analyses were made of the CO_2 in compost by connecting the rubber tubing to the Orsat apparatus.

CO_2 Evolution during Growth : It may be observed from Fig. 1 No. 3 and Table 1 that mushrooms growing in the bell jar with two outlets have distinctly elongated stems and retarded caps, even though no CO_2 was detected in the jar. That CO_2 was actively evolving from the soil (even when no sporophores were growing) could be proven by



Fig. 1. Effect on Mushroom Growth when covered with bell jars having openings at top (Nos. 1 & 2), and at top and side (No. 3). Pots Nos. 4 & 5 are controls.

closing the outlets of the bell jars with rubber stopper. Under this circumstance, the CO_2 in the jars increased to 18% in five days. So it may be inferred that the CO_2 diffused out completely from the bell jar with two outlets, but only partially from the bell jars with one outlet ; the amount of CO_2 accumulating in the latter depended on the diameter of opening.

Rate of Diffusion of CO_2 and Hypothetical Substance : From the fact that the mushrooms grew abnormally in the absence of CO_2 , it may be hypothesized that another volatile substance affected the growth. Carbon dioxide is a small molecule, with a small relative density or molar weight, with a very low boiling point and a gas at ordinary temperature. Accordingly, the rate of diffusion of CO_2 , considering Graham's Law of Diffusion, would be expected to be rapid, especially through the 'chimney' effect of the bell jar with a lower and upper opening. Reasoning similarly for the hypothetical volatile substance, it may be considered to have a large molecular weight, with a high boiling point and low volatility, so that its rate of diffusion would be much slower than that of CO_2 . Since the latter diffused slowly, a sufficient concentration was present in the bell jar, especially surrounding the sporophores, to affect the nature of their growth. Thus, by means of this bell jar with two outlets, it was possible to arrange for a differential rate of diffusion.

CO_2 Evolution after Watering : In Table 1 there is shown the increase in CO_2 concentration in the compost upon watering the soil. Normally the percentage of CO_2 is 0.2 to 0.6 ; after watering, there is a rapid increase to 1 to 2 per cent. or more, reaching a maximum in 24 to 48 hours, and then receding to the original low percentage over a period of some eight days. This rise and fall in CO_2 occurs whether sporophores are growing or not. The CO_2 in the compost does not appear to have any effect on sporophore development, unless it is allowed to accumulate at a high concentration in the atmosphere surrounding the sporophores. Lambert (2) found similarly that CO_2 introduced from a cylinder into the compost under growing sporophores, had no effect on their development.

No Damage to Mycelium by CO_2 or Lack of O_2 : That high concentration of CO_2 does not damage the sporophore-producing capacity of the mycelium may be shown by the following example : The opening in the bell jar was closed and the CO_2 allowed to accumulate for five days, so that the concentration reached 18%, and no oxygen could be detected. The sporophores therein grew abnormally and a distinct formaldehyde odour was present upon opening the jar. But twenty days after the bell jar was removed from this pot, a yield of 170 grams in one picking or "break" was obtained ; this yield is equivalent to 1.1 lb. per square foot. So the high concentration of CO_2 and almost complete absence of oxygen, not only was not injurious to the mycelium, but also had no injurious effects on the sporophore-producing power.

Abnormal Growth With and Without CO_2 : It is evident from Lambert's experiments that high concentrations of CO_2 , introduced from commercial cylinders, can affect mushrooms to grow abnormally.

Also, in Fig. 1, No. 2, where the concentration of CO_2 was high, the stems elongated severely. Accordingly, the abnormal growth can occur both at high concentrations and in the absence of CO_2 .

THE UNKNOWN VOLATILE SUBSTANCE DIFFUSING FROM MYCELIUM

Substance Diffusing From Mycelium: A hypothesis may be proposed that some volatile substance emitted from the mycelium in the compost and in the casing soil accumulates when there is insufficient ventilation or when the mushrooms are growing thickly on the beds. The writer (6) has detected a volatile substance or substances emitted from the mycelium by absorbing solutions of guaiacum resin or benzidine in pure filter paper, and then suspending the papers in bell jars over the pot of mycelium-impregnated compost. The papers become coloured blue and brown, respectively, indicating that the substance volatilizing is of an oxidizing nature. Adequate controls were, of course, carried out simultaneously by suspending papers containing the reagents in jars over pots of water. Similar colour changes were produced in agar slants as 'halos' advancing ahead of the growing mycelium, with these reagents as well as many others.

Defensive Mechanism of Volatile Substance: This volatile substance may also give some indication of a defensive mechanism (6). For example, when lead acetate test papers, darkened (showing evolution of a sulphide) by suspending them over cultures of *Pseudobalsamia microspora*, a pathogen of the mushroom mycelium, were suspended over mushroom cultures by the same procedure described above, the darkened papers were decolourized. This reversal by the volatilizing and diffusing substances from the mushroom mycelium may be interpreted as a defensive mechanism.

Oxidation-Reduction Reactions in Soil: The significance of this volatile substance may be, then, that it is a defensive mechanism and also that it inhibits fructification or affects normal growth when allowed to accumulate. The intensity or high potential of the substance diffusing from the mycelium was shown by embedding oxidation-reduction indicators in agar slants (7). It seems that the oxidizing intensity of this substance is so great that it prevents the thickenings at the ends of the hyphae or strands of hyphae from which the sporophores develop. The necessity to adjust the soil at a relatively high pH for best fructification, tends to show that the soil must be a medium suitable for rapid oxidation-reduction reactions. A movement of air or oxygen—ventilation—is, of course, required for such reactions. Accordingly, at least one of the functions of the casing soil is to provide an alkaline-oxygenated medium for the destruction of this volatile substance.

EXPERIMENTS ON WASHING ATMOSPHERIC GASES

Mader's Experiments with Air-Washing: Mader (4) also found that "wherever mushrooms are grown, substances of a volatile nature accumulate and become detrimental to their growth and fructification." He claims to have demonstrated experimentally the removal of the toxic substances inhibiting fructification by growing mushrooms to maturity in "air-tight chambers" of 12 cubic feet, and recirculating the atmospheric gases in these chambers by pumping them through air-washing equipment containing either mineral oil, alkaline permanganate

solution or activated charcoal. But the procedure he employed is open to serious criticism. For example, if the atmospheric gases were circulated through alkaline permanganate solution, the CO_2 resulting from metabolic processes would be absorbed, the oxygen would be consumed, and a partial vacuum would result. Mader does not mention any analysis for CO_2 or a partial vacuum, or introducing additional oxygen. It is not comprehensible how fruiting bodies of mushrooms could be initiated and develop normally in the absence of oxygen. Furthermore, his claim that the activated carbon absorbed CO_2 is not substantiated by the manufacturers of the canister of activated carbon he employed. In his use of mineral oil for air-washing he states that the CO_2 was not removed, so that the accumulation of this gas in the chamber resulted in malformed mushrooms. But according to the experiments of the writer mentioned above, with bell jars and glazed pots, the CO_2 in an air-tight compartment would increase to 18% in a few days and prevent all growth. In a private communication to the writer, Mader states that preliminary "trial runs were made in order to assure myself the equipment was air tight." That, although the air was not washed in the controls, due to a lack of a sufficient number of pumps, in the experiments reported in his publication, he did recirculate the atmospheric gases through water alone in preliminary experiments and obtained only a growth of mycelium and no fructification.

Stoller's Experiments with Air-Washing : The writer was not able to repeat Mader's experiments because pumps similar to those he used were not procurable. But experiments were performed in bell jars and glazed pots (8) in which atmospheric gases were recirculated through alkaline solutions. Rubber bulbs actuated mechanically were employed as pumps. The opening in top of bell jar was closed with a two-hole rubber stopper; glass tubes, passing through these holes to the surface soil, were connected in a train to a manometer, water wash bottle, and an alkaline washing solution. The partial vacuum resulting from the absorption of CO_2 and consumption of O_2 was clearly evident by reading the manometer. In fact, the rubber bulbs became indented after a few days due to the suction of the vacuum, and failed to function. This condition was corrected by admitting systematically, pure oxygen through a separate inlet. *Even so, only mycelium grew over the soil and no sporophores developed to maturity*, although there were some pin-size mushrooms at the junction where the soil broke loose from the side of the pot. When alkaline permanganate solution, as mentioned by Mader, was employed, there was a profusely dense growth of aerial mycelium over the soil. *Mature sporophores, however, were obtained by an arrangement to filter the air through the soil after it bubbled through a solution of NaOH.* In order for the air to filter through the soil, it entered through the hole in the bottom of the pot and went up through the tube to the petri dish under the casing soil, as described above for experiments to measure the CO_2 below the soil. It was interesting to observe that all the mushrooms developed to maturity were directly above the edge of the petri dish which was below the soil; that is, the mushroom developed where the air was filtering through the soil. It would have been interesting to have provided for a column of soil

in the gas train for filtering the air in order to distinguish whether a volatile substance was removed by filtering through the soil or whether the air had some more direct effect on mycelial growth. It is assumed, for the present, that a volatile substance was removed.

Conditions Required for Growth of Sporophores : From this experiment it may be surmised that three conditions are required for the normal growth of sporophores, namely : removal of CO_2 , a supply of O_2 , and filtration of atmospheric gases through the loam. Ordinarily the air is not filtered through the soil, but there must be some absorption of oxygen of the air in the soil or a dissolving of oxygen in the soil water, in order to account for the CO_2 actively evolving from the soil. It appears that there must be a relatively strong movement of air—or ventilation—in order for some reaction to occur on the surfaces of the soil particles where the mycelium has penetrated, to initiate fructification. If the air movement is insufficient in the soil-particle-mycelium environment, a reaction—possibly a conversion of some oxidizable substance—does not occur, and fructification is not initiated. If the air-movement or oxidizable process is insufficient after the sporophores have started to develop, then the accumulation of this hypothetical oxidizable substance promotes an abnormal growth of the sporophores.

Rate of Air Current and Sporophore Growth : It has been demonstrated by the writer (8) that a movement of the air can actually determine the character of sporophore growth, although these experiments were not repeated sufficiently to warrant a high degree of certainty. When the rate of a current entering the bell jars in which mushrooms were growing was 0.11 litres per minute, the stems were elongated and caps retarded. But when the rate was doubled (0.22 litres per minute), the mushrooms grew normally and weighed much more. The CO_2 present in former case was 0.4 to 0.6% ; in latter 0.2%.

Analysis of Mader's Experiments : In the light of these experiments it may be possible to come to some understanding regarding Mader's experiments. It would seem that his chambers and equipment were not air-tight. Oxygen diffused into the chambers when CO_2 was absorbed by the alkaline permanganate solutions. The rate of air current he employed—2 cu. ft. per minute—may have been sufficient to oxygenate the soil satisfactorily. It is possible, too, that under these conditions, washing the atmospheric gases may have a salutary influence in removing toxic substances.

Effect of Auxin-like Substance on Mushroom Growth : The question arises how the same hypothetical volatile substance can stimulate mycelial growth, promote elongation of the stem and retardation of the cap, and affect initiation of sporophores. Well, it is known that auxins or plant hormone-like substances produce different physiological effects in relationship to different concentrations. It is possible that the volatile substance from the mushroom mycelium stimulates mycelial growth at high concentration. When this substance is transformed by oxidation so that only minute quantities are present in the soil, the condition for initiation of sporophores prevails. If this substance is allowed to accumulate while the sporophores are developing, it may promote an elongation of the cells without growth by

cell-division, so that the cells nearest to the diffusion of this substance from the soil, elongate ; that is, the cells of the stem elongate, and the growth of the cells of the cap are retarded. This last assertion requires histological confirmation.

FUNCTION OF CASING BY USE OF PEAT

Use of Peat for Casing Beds : The practise of employing peat instead of loam to case the beds may shed some light, also, on the function of the casing soil (9). If the peat was entirely fibrous, similar to peat used for chicken litter, and the moisture content about 65%, then the mycelium grew through it quickly and usually no sporophores were produced. When the beds were cased with fibrous peat that was saturated with water (over 80% moisture) sporophores developed about $\frac{1}{8}$ inch to $\frac{1}{4}$ inch below surface of peat casing ; the mushrooms were normal and yield fair. When the beds were cased with peat which was more decomposed, black when wet, and practically non-fibrous—which was dug from lower strata in the bog—mushrooms grew normally and prolifically as on loam. It was necessary to maintain moisture at 65% to 80% to develop mushrooms. The pH of the peat as obtained from the bog was approximately 5.0 ; only a few breaks of mushrooms, ranging from one-half to one pound per square foot, were produced with the peat at this low pH. But when the pH was raised to 8.0 by mixing with CaCO_3 , the breaks were continuous and yielded normally. It is interesting, though, that even at pH 5.0 a yield of $\frac{3}{4}$ lb. per sq. ft. was obtained on peat, whereas the yield derived from a naturally acid soil (pH 4.8) was less than $\frac{1}{4}$ lb. per sq. ft. (3). By mixing the peat with CaCO_3 , it becomes even more plastic than in the original state. It was necessary to mix in addition a small percentage of CaSO_4 in order to give the peat a 'crumb' structure, so as to attain a better aeration. When the peat was mixed with gypsum the mushrooms grew uniformly over the entire bed surface, instead of sparsely in bunches.

"Closed-Room-Effect" with Peat Casing : The sensitivity of the mycelium growing in the non-fibrous peat casing to moisture and aeration in relation to the initiation and development of sporophores, is strikingly similar to the "closed-room-effect" observed by Mader (4) for mushrooms growing in limestone caves. If the moisture content of the peat was not maintained to near saturation after the mycelium grew into it, then the mycelium grew over the surface without producing sporophores. If the ventilation or air-movement was insufficient, the same condition occurred even in presence of sufficient moisture. If the ventilation was decreased (due to extremely low temperatures outside) after the sporophores reached the pin-stage, mycelial growth flourished and smothered further growth of the pins. If the compost projected in places above the surface so that the peat casing was relatively thin, a dense patch of mycelial growth resulted ; however, after this patch was removed and replaced with a thicker layer of peat, mushrooms grew normally. Areas where the ventilation was poor—'dead ends'—could easily be detected by similar dense, white, dried-out patches of mycelial growth. When the mycelium started to grow on the surface of the peat, corrective measures like dusting the surface with CaCO_3 were helpful if the ventilation was fairly adequate. It seems that these observations, on the use of peat for casing beds, tend to confirm the deductions made from the experiments on air-washing and ventilation.

TABLE 1. CO₂ in the Bell Jars and in the Compost of Pots shown in Fig. 1

No.	Diam. of opening top of jar (cm)	% CO ₂ in No. of days										Character of Growth		No. of Mushrooms per pot	Wt. of Mushrooms grams	
		Bell Jar					Compost in Pot					Cap	Stem			
		0	1	3	4	6	0	1	3	4	6					8
1	5.5	—	0.8	1.1	1.2	1.2	0.6	1.6	1.8	2.0	2.2	0.6	retarded	elongated	3	45
2	3.0	—	1.6	2.8	3.4	4.0	0.4	2.2	3.5	3.8	4.4	0.2	strongly retarded	strongly elongated	7	53
3	3.0*	—	0	0	0	0	0.2	1.0	0.9	0.8	0.8	0.2	slightly retarded	elongated	4	85
4	None						1.4	2.4	2.2	1.8	1.6	1.2	Normal	Normal	1	60
5	None						0.6	1.2	1.2	1.0	0.7	0.5	Normal	Normal	3	90

*opening on side of bell jar is 1.5 cm.

SUMMARY

1. **Relation of CO₂ to Mushroom Growth :** CO₂ actively evolves from the casing soil and compost, whether or not mushrooms are growing. Upon watering, the evolution of CO₂ is sharply increased, and then subsides again after a few days. High concentrations of CO₂ or complete absence of oxygen are not injurious to the mushroom-producing capacity of the mycelium. Mushrooms (sporophores) develop abnormally in the presence of high concentrations of CO₂ ; however, abnormal growth may also occur in the absence of CO₂. It is assumed that a volatile substance, besides high concentration of CO₂, is related to the occurrence of this abnormal growth.
2. **The Unknown Volatile Substance Diffusing from the Mycelium :** Several methods were described for detecting a volatile substance diffusing from the mycelium. The function of this volatile substance is explained as acting similar to a plant hormone-like substance, producing different effects at various concentrations : When present in large amounts, it stimulates mycelial growth and protects such growth from attacks by other moulds ; if it is destroyed in the casing material or present in very low concentration, fructification is initiated ; if allowed to accumulate in the casing, it affects normal growth of mushrooms.
3. **A Function of the Casing Soil :** It appears that the oxidizing intensity of this substance is so great that it prevents the thickenings at ends of the strands of hyphae from which the sporophores develop. Accordingly, one, at least, of the functions of the casing soil is to provide an alkaline-oxygenated medium for the destruction of the volatile substance.
4. **The Effect of Ventilation of Mushroom Growth :** It was demonstrated in experiments on ventilation that the requirements for normal sporophore production (after providing for proper moisture and pH of soil, and suitable compost) are : removal of CO₂ ; a supply of O₂ ; and filtration of atmospheric gases through the loam. Ordinarily, instead of filtration through soil, a provision is made for forced air-movement or ventilation.
5. **Function of Casing Using Peat :** Non-fibrous peat mixed with limestone and gypsum makes a good casing for mushroom beds. The importance of a sufficient air-movement or ventilation is strikingly demonstrated when beds are cased with peat.

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A. Campbell Melville *writes about*

PEAK-HEATING BY CALOR GAS

Some time ago, the MRA mentioned that experiments had been carried out at Yaxley with Calor Gas for peak heating in place of coke braziers.

At the time I was interested in this as a future possible but at that particular period I did not possess a proper heat-up room. Time passed, however, and with the loss of a great deal of perspiration and energy, I converted a building into a peak heating room. It is unnecessary for me to go into the details of the peak heat room as it serves no purpose in the ultimate aim of this article. I will only say it is almost a one hundred per cent. job.

I started off with the assistance of coke braziers as a boost and, never liking coke braziers with their usual attendant fumes, clouds of smoke in the initial stages, and the none too comfortable transportation of same into the peak heat room, I decided to contact the Calor Gas people on the possibility of using gas.

They advised me to use four gas burners. The burners are made in the form of a steel tube two feet long with hack saw "cuttings" on the top of the tube; the "cuttings" are $\frac{3}{8}$ in. apart and run almost the entire length of the tube. The tube is held in position by clip legs at either end. Each burner has a separate valve. Each burner is joined to one main pipe which in turn is connected to two gas cylinders coupled up together. A controller is of course fitted to the outflow.

The main gas feed pipe was run through the wall of the heat-up room and the boiler house where the gas cylinders were kept. The whole set up can be assembled in minutes.

I have had many interesting discussions on Calor Heating with many people, and each and every one has said, "Oh, but how costly to run." On this I agree, but I only agree it is costly because of the more or less insurmountable difficulties which present themselves as the peak heating continues. Costly, because one is totally unable to obtain the maximum heat from the burners which simply peter out due to the lack of oxygen. The efficiency of the burners and the actual heat from the burners are most satisfactory, and I believe the entire idea is really good, but for the curse of the burners gradually dying and the room filling with gas. It is heartbreaking to open the door or vents to allow the burners to revive and at the same time to lose valuable heat. On the other hand, it is exceedingly dangerous to have live gas floating around in the room with say, three burners out and the remaining one almost out. One is liable to be shot out of the room at any moment if the gas should ignite. This is a Bad Thing!

I peak heat by steam which is raised by an ordinary steam boiler with an oil conversion. This is most satisfactory. My original idea for Calor Gas was to run the steam alternately with the gas particularly at night, when gas would give a constant heat; whereas coke would die out through exhaustion. Like most mushroom growers I am always in the line of least resistance.

Regarding cost, you obtain two cylinders which contain 208 cubic feet of gas. The burners pass 6 cu. ft. per hour. Each cylinder cost £1 3s. 0d. The cost of one cubic foot of gas is 1½d. I reckon that 2 cylinders can easily do the job in my case.

Earlier I said it was costly. It is only costly because I am totally unable to get the maximum heat from the burners ; but believe me it would most certainly not be costly if the oxygen difficulty could be overcome in a practical way. Please take into account the shocking business of coke braziers from start to finish, including the riddling of dead embers on a windy day.

Meantime I retain the gas plant, but I have returned to coke braziers. If any member is thinking of using Calor Gas heating, my advice is—think well and hard first!

Dr. R. L. Edwards was asked by the Editor for his observations. He replied as follows :

“Coke braziers, Calor Gas burners, or any appliances consuming fuel inside a closed building require ventilation to supply oxygen for their continued burning.

“The actual loss of heat removed by outgoing hot air is a very small fraction of that produced; unless the ventilation provided is grossly excessive.”

“I agree that steam and electricity are both preferable, where they are available for peak heating.”



M.G.A.? M.R.A.?

Confusion between the Mushroom Research Association Ltd. and the Mushroom Growers' Association still exists in the minds of some growers. Their respective functions are briefly as follows.

The M.G.A. is a specialist branch of the National Farmers' Union (membership 200,000) and was started by growers and run by them to assist members with their practical and administrative problems, to represent them in matters affecting Government policy, and generally to protect the interests of the man who grows the crop. Refresher Courses, Open Days, Trade Shows, Meetings and “Farm Walks” are held during each year ; all the literature it publishes is free to members.

The M.R.A. was formed to carry out research for the improvement of mushroom growing. Its first big job was to produce a synthetic compost which would replace horse manure, and it is now doing equally important work on casing soils and diseases. All subscribers receive its reports without further charge. It also examines specimens and gives technical advice on any question sent in by subscribers. It receives a Government grant in proportion to growers' subscriptions.

On the advisory side particularly the Associations help each other, and as a result are better able to help growers. The Research Association benefits from the frequent contact with practical growers, while it originated much of the technical advice now available from the Growers' Association.

The Merits of **FORCED DRAUGHT EQUIPMENT**

*By C. H. FAWCETT, A.M.I.E.E.
Director, Burgess & Co. (Engineers) Ltd.*

With fuel costs rising year by year, every Grower is faced with the need to find a means of lowering his production costs to compensate for the higher fuel bill. One method of achieving this goal is the use of forced draught equipment.

Under natural draught firing, air is brought through the firebed by the chimney draught, and the strength of this draught governs the lower limit of the size of fuel that can be burnt and the depth of the firebed. If the fuel is too small or the bed too thick, the fire will not "draw" but will gradually die out. To assist the draught, air spaces $\frac{3}{4}$ "— $1\frac{1}{2}$ " wide are left between the firebars.

Because very small fuels such as coke breeze, coal slack or dross cannot be burnt on ordinary fires, these fuels are cheap to purchase and are generally unrationed. The purpose of forced draught equipment is to enable these low grade fuels to be burnt and to give a measure of thermostatic control.

The base or ashpit of the boiler is sealed up and air is blown into the sealed ashpit by means of a low pressure fan. It is important that a low pressure fan be employed or damage may occur to the boiler. The fan is fitted with a damper to give control of the rate of air supply and hence the rate of burning.

The ordinary firebars with wide spaces are replaced by special deep bars having very narrow spaces—not more than $\frac{1}{4}$ " wide. The small spaces ensure that the fuel does not drop through the bars and become wasted and also, but perhaps even more important, serve to prevent "blow holes" forming in the fire. Such blow holes are the cause of damage to the boiler. They should never be found on a sound installation.

Control of the fan, i.e. when it runs and when it stops, is obtained either from an air thermostat in the houses being heated or by an immersion thermostat in the water system. If the house (or the water) is too cold the fan will run, build up the fire, and so raise the temperature. As soon as the required temperature is reached the fan will stop and, because the ashpit is sealed, the fire will go dormant again until the next occasion that the thermostat calls for more heat. In periods of mild weather when the fire would not be called for by the thermostat for several hours, the fire would die out if some device were not fitted to keep it alight. A simple and inexpensive time switch is employed as a re-kindling control to make the fan run for say 3—5 minutes in every hour.

It is true to say that any fuel that can be burnt on an ordinary fire can be used equally well with forced draught but in addition it can utilise a wide range of low grade fuels at more reasonable prices.

These vary from district to district but include anthracite smalls from $1\frac{1}{4}$ "—0, furnace coke breeze, gas coke breeze from $\frac{3}{4}$ "—0, bituminous smalls, slack, dross, etc., from 2"—0, opencast unscreened fuel, town cinders and pan coke.

The cost of installing such a plant will depend upon the size of the boiler, electricity supply, etc., and may be from £75—£100. The saving in running cost can be as great as 50% even after making allowance for the extra quantities of low grade fuel needed to compensate for the lower heat content.

It will be seen therefore that under favourable conditions the complete installation cost can be recovered in less than one season.



MIDDLEBROOK SUGGESTS MONOGRAPHS

Writing in *The Gardeners' Chronicle* (26.5.51) on the recent heavy "flush" of mushroom textbooks, Mr. Stanley Middlebrook concludes : "Much as these books are welcomed by commercial, amateur and even prospective growers, I would suggest that instead of such sudden extravagance of general literature attempting to cater for the advanced specialist and the backyard beginner in one and the same volume, technical literature for the established industry should now take the form of specially commissioned monographs on each of our main problems. This would simplify the *popular* books on the subject by cutting out the *heavy going*, and would relieve the specialist grower of the elementary information."



MUSHROOM COMPOST FOR DENUDED LAND

By J. WATTS

The use of land that has been denuded in the quest for soil for casing must in some respects present a problem to many growers. The new American product Krilium may prove to be the answer and bring back fertility to these areas, but even if successful it will take a good many years before full results are to hand.

During this winter I decided to try out strawberries in boxes on shelves in greenhouses, one house heated, the other not. Being pressed for time I filled the boxes with mushroom compost taken straight from a mushroom house, casing soil included. A sprinkle of hydrated lime was added, but that is all.

The varieties tried were Royal Sovereign and Cambridge 257. Result : Exceedingly fine plants which yielded just on $\frac{1}{2}$ lb. per plant from Royal Sovereign and $\frac{1}{4}$ lb. from Cambridge. Prices started at 14/- a lb. and did not drop below 7/-. In the heated house the starting price was 21/-.

From this it does appear Strawberries will do well in mushroom compost and that a 4" layer on land from which the top layer has been removed for casing could bring it back into use. Cloches should be well worth while. And the used mushroom compost would be bringing back £ s. d. over a number of years. Anyway, the idea may provide food for thought !

Correspondence

I have noted that you intend to put up the Honorary Membership **subscription**. I quite agree with this move and I think the commercial grower could well afford a doubled fee too. The help and information growers and other enthusiasts (like myself) get from the MGA and through the Bulletin must to many of them be worth ten times the fee hitherto payable.

Major D. A. WILSON.

In the June Bulletin you published a letter from me in which I calculated there was a saving of £11 or £12 for every day by which the composting period was reduced. Would not the possession of a **pH meter** enable the grower to assess the moment to stop composting more accurately than is possible by imprecise tests such as smell, colour and shearing? A grower might wait several more days, relying on these tests, but if he saw the pH was well down in the sevens he could put his manure in the beds straight away. Is it possible that the pH could be right when the compost does not answer all the physical tests? Conversely, do you think there are cases when a manure answers all the tests but the pH is too high?

Lt. Col. E. NOEL.

PRICES—Growers' and Retail

Mrs. C. J. Green has written to the Editor from Somerset: "If the cost of growing mushrooms is 3s. per lb. (allowing for gross profit), as I am told it is, it would be very interesting to a mere consumer to know whether the demand for mushrooms has really grown, or is estimated as being likely to grow, sufficiently to warrant the attempt to develop the mushroom industry.

"That is one aspect. Another is, *why* are mushrooms quite frequently not obtainable under 8/6d. to 10/- per lb. to the consumer? It seems to me that the difference of anything up to 7/- per lb. for distributing and retailing is quite abnormally high. Surely it is time definite action should be taken to cut the transport and distributors' costs?

"The time has come when the consumer can no longer spend without serious consideration so much money on something which is not a necessity to living. I and my family are particularly fond of mushrooms and would have them quite frequently, and no doubt there are many like us, but we do feel there ought to be much more consideration shown regarding the selling price."

The Grower made this comment in a leading article on 28.6.52: *One reason for the great difference between growers' prices and retail prices is the enormous wastage that takes place in the chain of distribution, because of deterioration of the produce. Far too little attention has been given to this, especially by those who build grandiose schemes for the reform of horticulture.*

Perhaps a Wholesaler member, and a Retailer, might care to comment briefly on Mrs. Green's letter?

ANGMERING WALK

Close on 200 mushroom growers met at Messrs. W. Darlington & Sons Ltd.'s Lucksfield Nursery, Angmering, on 2nd September. It was one of a successful series of Walks organised by The Worthing Central Mutual Aid Group.

Mr. O. E. Gahm, the firm's Technical adviser, took the party round the mushroom nursery and with the Group's microphone kept everyone fully informed as to what was taking place.

The cropping houses are unusual in the Worthing district. They consist of metal glasshouses lagged with glass wool, covered with roofing felt and kept in place with wire netting. Mr. Gahm explained that this gave excellent insulation even in a hot summer.

The evening came to a pleasant conclusion in the packing shed, where Messrs. Darlington kindly provided refreshments. After Mr. Gahm had answered many queries Mr. F. R. Frampton, the Group's leader, thanked him for his lucid commentary and detailed replies to questions, and Messrs. Darlington for their invitation and hospitality. He also appealed for more members to join the Group, and later the Group's hon. sec. (Mr. G. H. L. Ellis) was able to report a handsome response.

NEW (AUGUST) MEMBERS

Allerton, F. W., c/o Geo. Monro Ltd., Hertford Road, Waltham Cross, Herts.
Aubrey, R. W., Derwen, Pontfadog, Wrexham.
Claridge, R. L., 2 Old Orchard Cottages, Parsonage Lane, Farnham Royal, Bucks.
Crowther, Miss E., Lake House, Quorn, Leics.
Drittsleder Knud Refstrup, Norsk Champignon, Økern, Norway.
Godson & Mallard Ltd., Stirling Chambers, Chapel Road, Worthing, Sussex.
Hales, K. L. G., Harringcourt, Pinhoe, Exeter.
Harris, C. B., Umsintsi Boshkop, P. I. Honeydew, via Johannesburg, S.A.
Hullen, W., Champignons-Grosskulturen, Baggarten 1, Hamburg 26, Germany.
Jenks, Norman S., Pilsdon Manor, Nr. Bridport, Dorset.
Knight, J. R., "Dukes," Allen's Green, Sawbridgeworth.
Lance, Richard G., Raggs Corner, Nether Wallop, Hants.
Mattson, Mrs., Fammarp Sondrum, Halmstad, Sweden.
Maude, R., 66 Crown Street, Halifax, Yorks.
Nagel, Dr. W., Mannheim-industriehafen, Waldhofstr 252, Germany.
Otto, Mrs. E., 2 Jonkershoek Road, Hill Extension, Johannesburg, S.A.
Proctor, J. N., The Haven, Minskip, York.
Ralph, T., Askholme Hill Nurseries, Hedon, Nr. Hull.
Sanderson, Leonard, 15 Oldfield-Carr-Lane, Hardhorn, Blackpool, Lancs.
Ward, D. E., Tom's Hill House, Aldbury, Tring, Herts.

CHANGED OR CORRECTED ADDRESSES

Abbiss, H. W., c/o Sutton's Advisory Service, Reading, Berks.
Cluwin, A. R. Meyer, 1 Deken van Somezen Straat, Eindhoven, Holland.
Hedley, Dr. E. P., 16 Gillato Road, Westridge, Durban, S.A.
Stephenson, C. H. & F., Canal Wharf, St. Andrews Road, Aspley, Huddersfield.

Italics indicate Honorary Membership.

No business can expect to enjoy prosperity if it does not take notice of what its customers require. . . . It will become necessary to pay as much attention to the utilization and **marketing** of a crop as to its production, and the closest co-operation between growers, packers, storers and processors will be essential.

C. E. PEARSON in *Agriculture*, March, 1951.

Taking the average (tomato) grower it was clear that if any economies were going to be made in production costs, those economies must be made in . . . labour, fuel and manure.

Dr. L. G. BENNETT in *Fruit Trades' Journal*, 24.3.51.

Synthetic "Soil Conditioners"

It has been known for some years that certain chemicals known as "polyuronides," which can be produced by micro-organisms, stabilise granular structure in soils, holding the very fine soil particles together in small lumps. These withstand wetting, absorbing as much water as they can and allowing the rest to drain away freely through open pores, so that some air space is maintained in the soil. On the other hand a soil without such structural stability breaks down much more easily when wet and forms a closely packed cake which does not drain and does not allow air to pass through. When such a caked soil dries it cracks and the cracks allow any water applied later to run through without being properly absorbed by the soil.

Two new products have now appeared on the market, and there may be others, which have been made specially to reproduce the soil stabilising effect of the polyuronides. Like these, the synthetic soil conditioners are made up of chains of small units with the desired properties, but the synthetic products are based on a unit which is easy to manufacture in quantity, and they are also much more slowly broken down in the soil than are the natural polyuronides.

The two soil conditioners recently announced are "**Krilium**," made by the Monsanto Co., and "**Aerotil**," made by the American Cyanamide Co.

We have not yet had time to complete the tests which are in progress to study the effect of Krilium on soil structure. *If soil conditioners can conveniently be used to prevent weak casing soils panning, and to increase the water retention and porosity to air, or even one of these things, they would be useful to many mushroom growers.*

One practical difficulty is that the conditioners do not create structure, they only protect it when it has been created, and a very fine soil which has no granular structure must be worked into lumps, preferably after adding the soil conditioners. This would, of course, have to be done before casing, most conveniently in a cement or compost mixer. A soil which had good structure but collapsed easily on watering could presumably be treated by watering with a solution of the conditioner after casing.

It therefore remains to be seen how far these new products can be used in mushroom growing, but if the makers' claims hold good under our conditions, and if convenient methods of application can be found, **these conditioners should make some growers' casing soil problems easier.**

R.L.E.

CORRECTION : Dr. E. B. Lambert asks us to correct an error in the original article on *An Improved System*. In the second paragraph on p. 274 of September Bulletin 33 the figure should be 10% Parzate, not 1%.

THE KING OF MUSHROOM HOUSES



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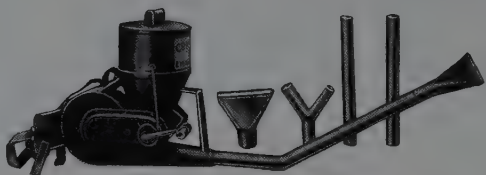
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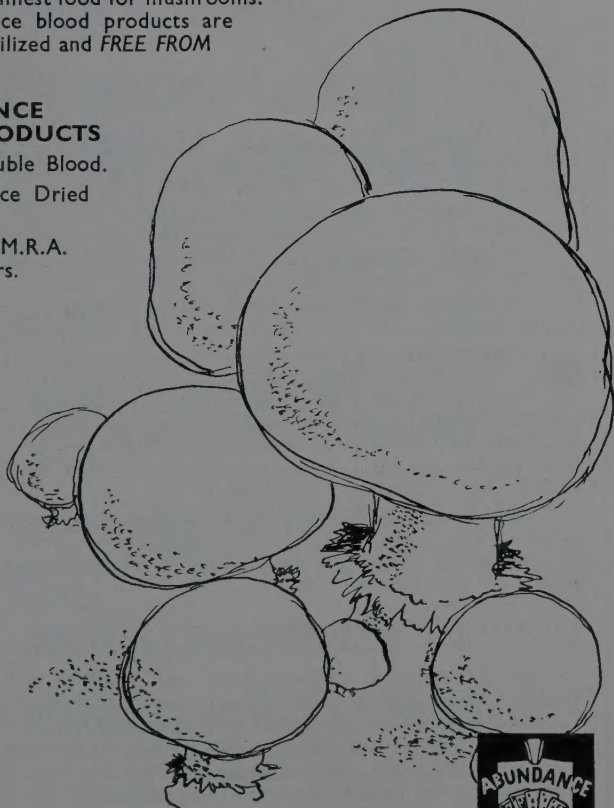
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SMALL ADVERTISEMENTS (3d. a word)

IMPORTANT NOTICE: The next *Mushroom Industry Exhibition* will be held in the North of England, probably at Harrogate, in late September or early October, 1953. It is likely that the Annual General Meeting of the MGA will take place during the same week.

D.V.M. (15) POWDER. (ZINC ETHYLENE BIS-DITHIOCARBAMATE). THE ORIGINAL MATERIAL AVAILABLE FROM STOCK. 7-lb. bags 5/6d. per lb.; 14-lb. bags 5/3d. lb.; 28-lb. bags 5/0d. lb. J. E. R. SIMONS LTD., HARLOW, ESSEX. Phone: POTTER STREET 65.

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SMOKE BOMBS, BHC DUSTS, DDT DUSTS. All best known brands Insecticides and Fungicides available. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone Potter Street 65.

MUSHROOM GROWERS' supplies of all kinds, consult J. E. R. SIMONS LTD., Harlow, Essex. 'Phone Potter Street 65. Telegrams Simons Harlow. Sole distributors of MOUNT MUSHROOM SPAWN.

MUSHROOM VISION PUNNETS ex stock.
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STEEL WINDOW CASEMENTS, unused, 8 ft. by 4 ft., with revolving central window, for sale £5 ex. Noble Mushrooms Ltd., Yaxley, Peterborough.

CHIP BASKETS & PACKAGES at competitive prices. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone: Potter Street 65.

"BAXI" PATENT HOT AIR STOVE FOR MUSHROOM HOUSES, GREENHOUSES, GARAGES, WORKSHOPS, etc. Write for particulars: RICHARD BAXENDALE & Sons Ltd., CHORLEY, LANCs.

TRAYS. We can quote you for various types. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone: Potter Street 65.

HOSEPIPE, sprayers, barrows, tools, and 1,000 other bargains!!! Catalogue free. GREENS STORES, 591 Albert Street, Lytham.

TRIGGER LANCES. To fit $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ " & 1" Hoses. Complete with Oval Rose, 37/6d. plus postage. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone: Potter Street 65.

EXCELLENT OPPORTUNITY for partnership in existing mushroom farm in Northamptonshire. Write B. Lilley, 8 Alexander Terrace, Finedon, Wellingborough.

The Secretary has a number of 5/- copies for sale of "**Mushrooms Galore**," André Simon's comprehensive selection of mushroom recipes. The latest press review comes from the *Otago Daily Times*, New Zealand: "Not many fruits, vegetables or meats achieve the distinction of having a book written solely about methods of preparing them for the table. Not only has the mushroom attained this distinction, but the author of the book is no less a personage than André Simon, president of the Wine and Food Society, and the volume is dedicated to that connoisseur of good living, Compton Mackenzie." Congratulations, by the way, to Sir Compton on his belated knighthood!

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The Diarist works overtime and invites you to **THE ANNUAL LUNCHEON**

(Advert)

Sept. 6th. Not only relegated, but nearly edited out of existence. F.C.A. now says this page has to be a luncheon advert. Result : a published display of the chaos which prevails when, even deeply humiliated, I try to co-operate with that man.

SEE YOU ON OCTOBER 1st (Advert)

Sept. 8th. I have it on good authority that he's going to see *me*. That is the one day he relents : he has promised me a double firewater—an historic moment which no incredulous member should miss !

YOU WON'T BE THERE?—WHY NOT?

Aren't you sociable ? Aren't you an angry member bursting with criticisms of the MGA ? Haven't you any problems ? Don't you want to raise your voice when the question of raising the subscription comes up ? Don't you want to shoot the committee and get a new one ?

(Advert)

Sept. 9th. Do you hate your neighbour-grower ? Take an aperitif with him. Do you think your spawn maker, your salesman, your sundriesman, your Inspector of Taxes, or your MGA treasurer is swindling you ? Go to the MGAAGM and have a grumble. Have *you* ever stood me a drink at a pre-Luncheon session ? Will you ? That reminds me ; the kind spawn maker who owes me a bottle of whisky will probably be making a public presentation on Oct. 1st. Will you, Sir ?

I BET YOU WILL!

(Advert)

Sept. 10th. Just phoned the Editor. Bet him this year's Luncheon (CONNAUGHT ROOMS, OCT. 1st—*advert*) will be the best attended ever. If I win he pays my next year's subscription (I hope it's raised to 10 guineas !) If I lose he is to have my diary notes for 12 months without payment. Stop !—I know what you're thinking. Gentlemen, can you imagine how bad they would be if they *weren't* paid for ?

Sept. 11th. A grower writes : " I get 1½ lb. in 24 days on trays and 5½ crops a year. Who says trays are no good ? " I do ! See me about it

ON OCTOBER THE FIRST (Advert)

In spite of, or because of, Stanley Middlebrook's nonsense, tickets are still available if you phone or wire immediately—EDITOR.